IWGGMS 17
THE 17TH INTERNATIONAL WORKSHOP ON GREENHOUSE GAS MEASUREMENTS FROM SPACE

NASA
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VIRTUAL MEETING

Overview of the MAGIC initiative for GHG and future plans

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Monitoring of Atmospheric composition and Greenhouse gases through multi-Instrument Campaigns

The MAGIC initiative was launched in 2017 by CNRS and CNES.

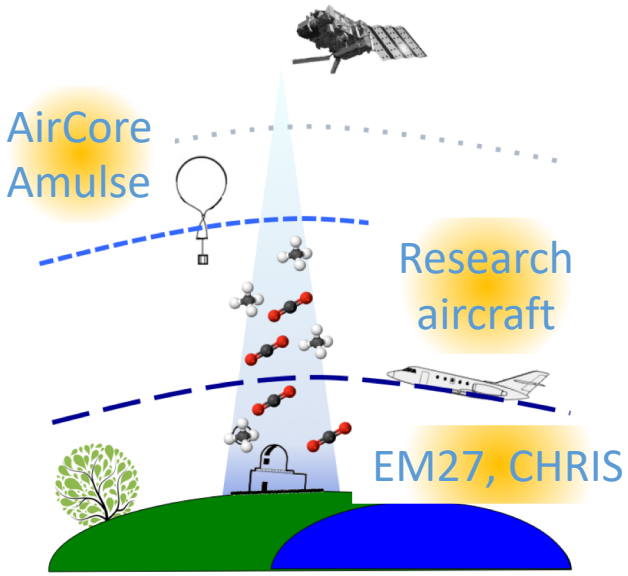
Two main objectives:

- To better understand atmospheric distribution and emissions of CH_4, CO_2 and related variables
- To validate current space missions (e.g. OCO-2, GOSAT-2, S5P, IASI) and prepare future ones (e.g. Merlin, MicroCarb, IASI-NG)

How?

- By organizing annual campaigns, network measurements and building numerical tools.
- By combining ground-based, airborne (aircraft, balloon) and satellite observations.
- By testing satellite airborne demonstrators.

Multi-instrument campaigns



Network for vertical profiling

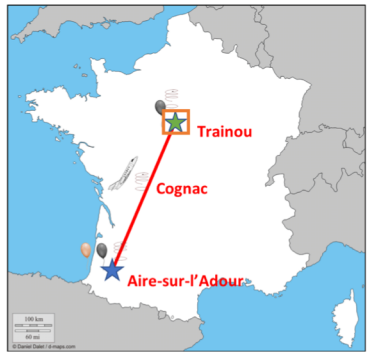
Consortium for total column measurements

See Y. Té's poster Session 2.2b

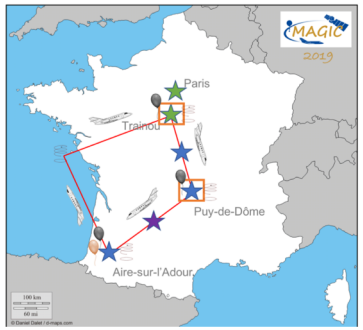
Funding: cnes, cnrs, EUMETSAT, esa, cea, Sorbonne Université, Université de Reims Champagne-Ardenne, Université de Lille

Already 3 campaigns: May 2018, June 2019, September 2020

MAGIC-CoMet 2018



MAGIC 2019



MAGIC 2020

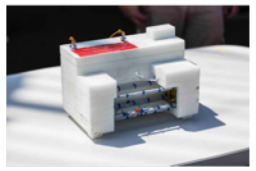
Primary objectives of these past campaigns:

1. Comparison and validation of various instrumental techniques.
2. Validation of 4 space missions: IASI-A/B/C, OCO-2, Sentinel-5P, GOSAT-1/2

Location: France around 3 stations: Aire-sur-l'Adour (ASA), Trainou (TRN, ICOS/TCCON), Puy-de-Dôme (CO-PDD)

Weather balloons

AirCore-light



Amulse

Calibration chain

→ 0-30 km profiles of CO_2, CH_4, CO, H_2O, T, wind

FTIR

EM27/SUN

CHRIS (TIR-SWIR)

→ Weighted columns of CO_2, CH_4, CO, etc.

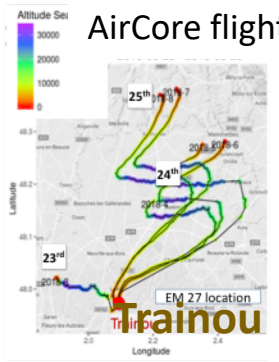
SAFIRE Falcon20

- Picarros
- SPIRIT
- Dropsondes
- Particules

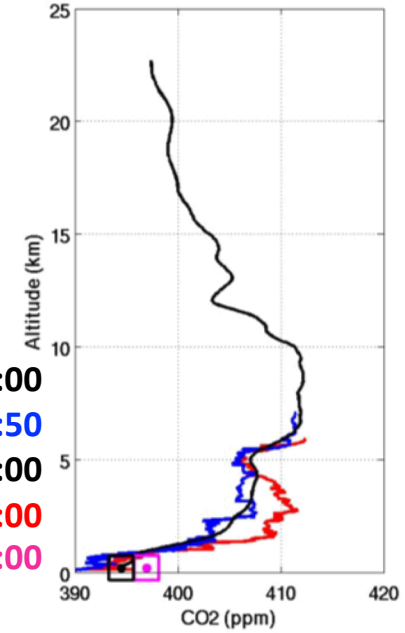
→ 0-11 km profiles of CO_2, CH_4, CO, H_2O, T, wind

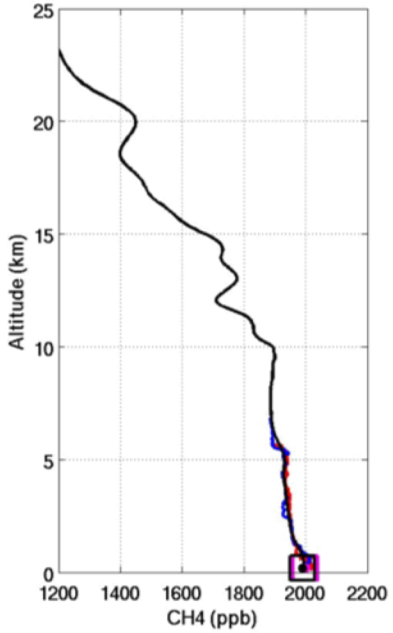
Results 1. Comparison of atmospheric profiles

AirCore vs. **Falcon20** vs. **ICOS tower** @ Trainou

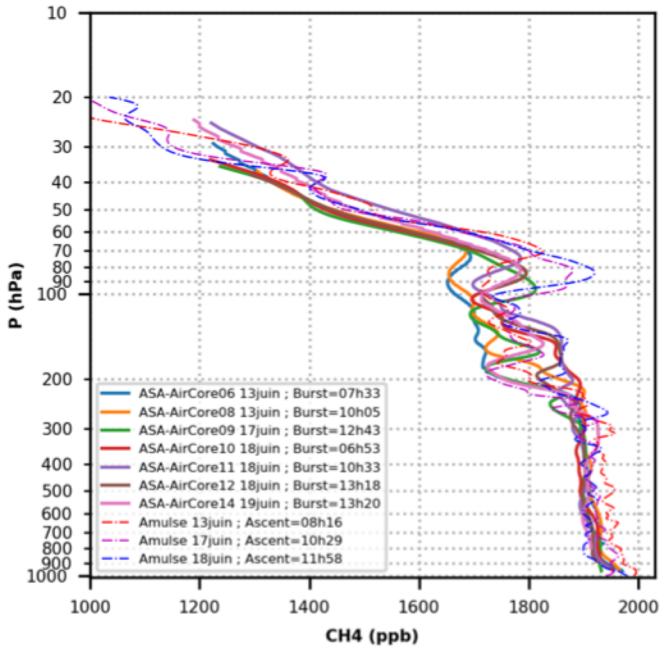


AirCore 006 11:00
Falcon20 - landing 10:50
ICOS-180m 11:00
Falcon20 - take-off 12:00
ICOS-180m 12:00

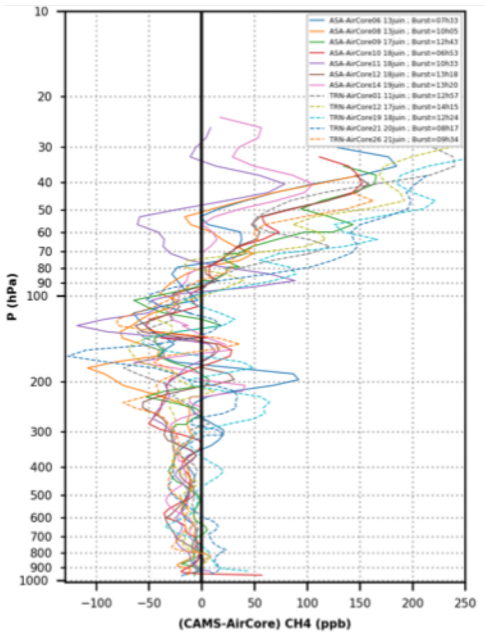




AirCore vs. **Amulse CH_4**



CAMS - AirCore CH_4

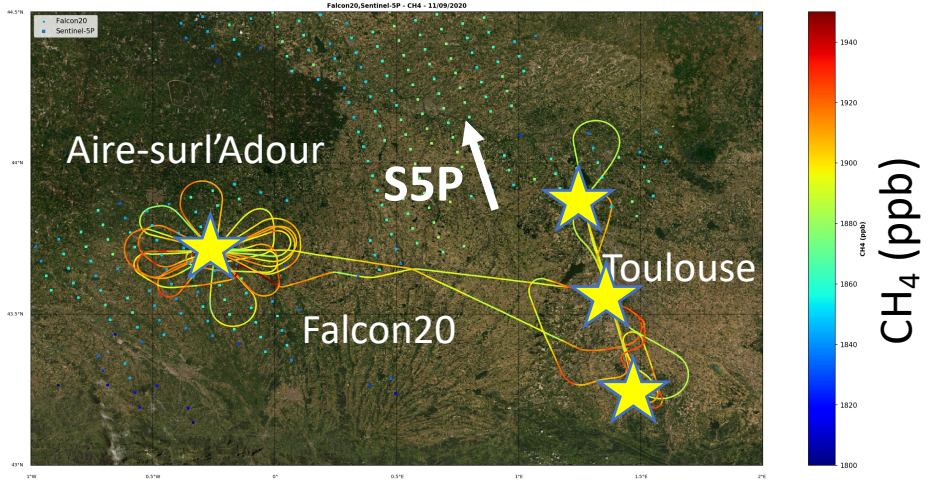


- Excellent agreement between AirCore, Amulse and Falcon20 throughout the troposphere.
  → Over the whole MAGIC flights, CH_4 'column' difference AirCore/Amulse - Falcon20 is : -1.58 ± 6.94 ppb
- Small discrepancies between AirCore and Amulse in stratospheric structures.
- Both AirCore and Amulse highlight overestimation of stratospheric CH_4 by several atmospheric transport models.

Results 2. Validation of various space missions: OCO-2, Sentinel-5P, GOSAT, IASI,

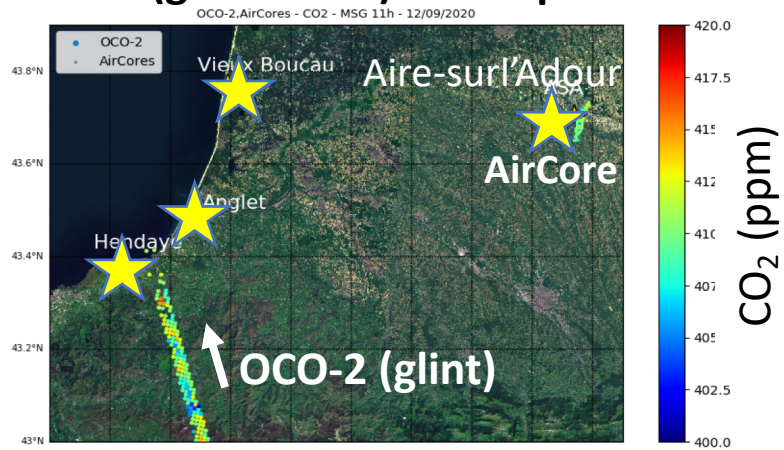
Satellites vs. EM27/SUN

TROPOMI/Sentinel-5P - 11 Sept. 2020



XCH_4^{S5P}-XCH_4^{EM27}= -2.6 ± 23.7 ppb

OCO-2 (glint mode) - 12 Sept. 2020

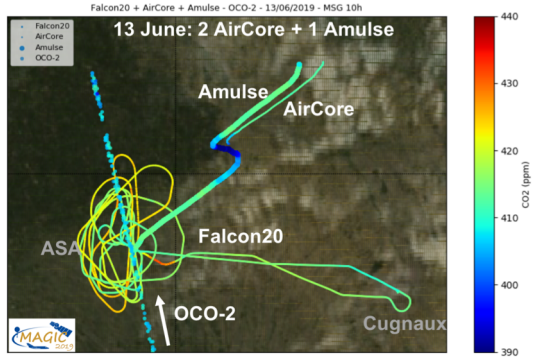


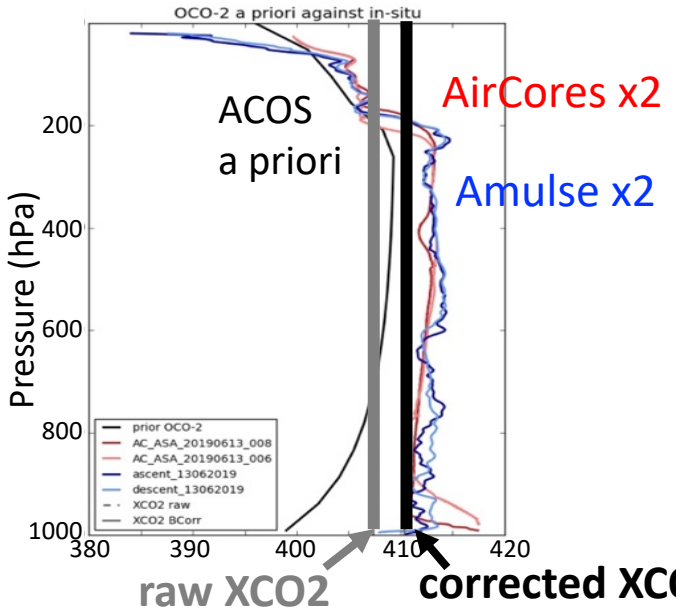
$XCO_2^{OCO\_corr}$ = 408.98 ppm

$XCO_2^{EM27/SUN}$ = 408.89 ppm

Satellites vs. AirCore/ Amulse

OCO-2 (nadir) - 13 June 2019





Mean difference OCO-2 - AirCore/Amulse XCO2:

- Raw XCO2: -3.10 ± 1.41 ppm
- Corr. XCO2: -0.39 ± 0.80 ppm

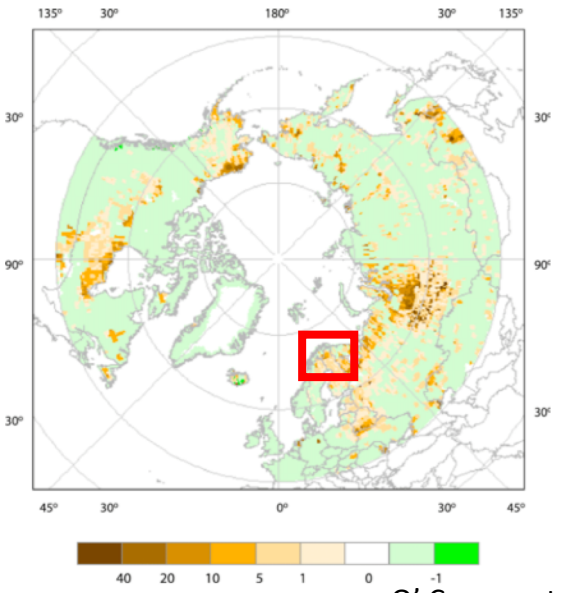
→ A database to evaluate impact of spectroscopy and CIA modelling on retrieved XCO2.

See M. Dogniaux's poster Session 1.5a

MAGIC2021: Towards high latitudes

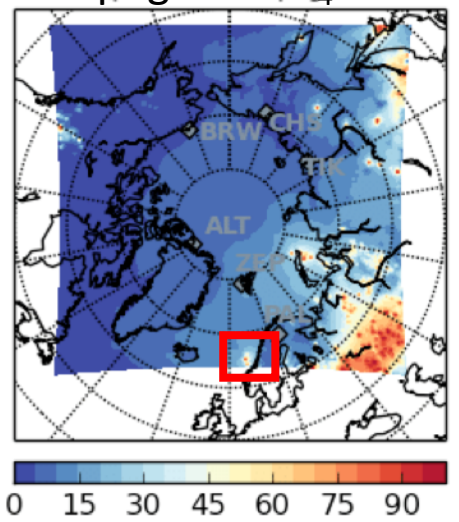
- **Specific objectives:**
  - **CH_4 and CO_2 emissions at high-latitude (~68°N)**
    - High northern latitudes are a major yet poorly known contributor to the global methane budget.
    - Natural and anthropogenic emissions
  - **Validation of space missions in this difficult environment.**
    - Passive space missions: difficulties due to specific obs conditions (high solar zenith angle, surface and thermodynamics conditions) and lack of validation.
    - Active space missions: an opportunity to bring new high-quality measurements.
- **Date and location:**
  - 14-27 August 2021
  - Northern Scandinavia; base of operation: Esrange station (Sweeden).
- **Team:**
- **Funding**: CNES, CNRS, ESA, DLR

Wetland CH_4 emissions



O' Connor et al., 2010

Anthropogenic CH_4 emissions

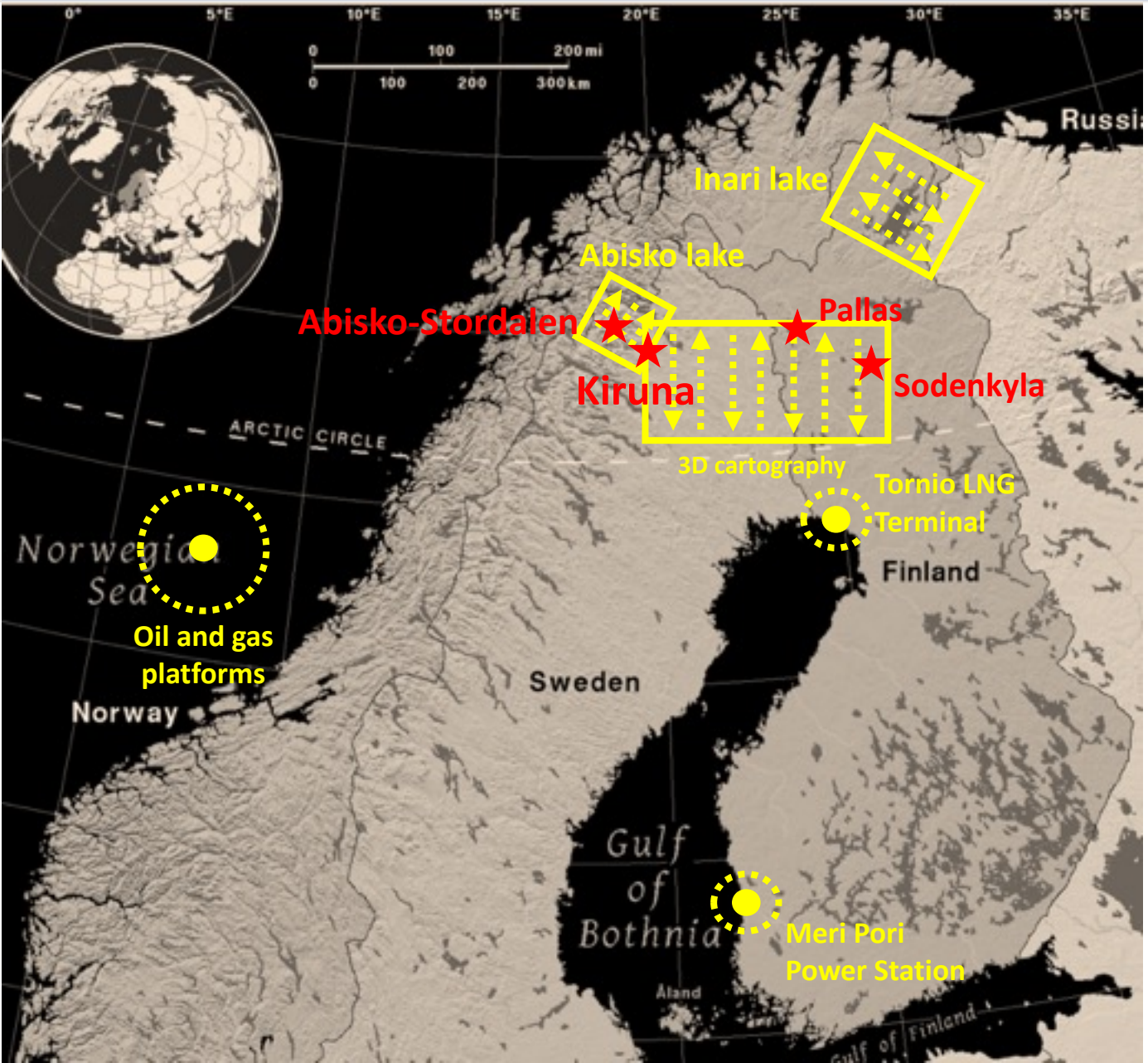


Thonat et al., 2018

MAGIC2021: List of instruments

Vectors			Instruments		Team	Observation
Balloons	Weather balloons (BLD) @Esrange		AirCore-light	5	LMD	0-30 km profiles (CO_2, CH_4, CO, N_2O, T, H_2O, wind)
			Amulse	5	GSMA	0-30 km profiles (CO_2, CH_4, H_2O, T)
	W. balloons @ Sodenkylä		AirCore	-	FMI/RUG	0-30 km profiles (CO_2, CH_4, CO, T, H_2O, wind)
	Stratospheric Balloons (BSO) *SUPER CLIMAT @ Esrange*		AirCore-HR	1	LMD	0-30 km profiles (CO_2, CH_4, CO, T, H_2O, wind + *C isotopes, N_2O*)
			AirCore-light	2	LMD	
			Amulse	1	GSMA	0-30 km profiles (CO_2, CH_4, H_2O, T)
			SAMPLE	1	GSMA	0-30 km profiles at a few points (CO_2, CH_4, H_2O, T)
			SPECIES	1	LPC2E	0-30 km profiles of many trace gases at ppt level
Ground	FTS		CHRIS	1	LOA	Weighted columns XCO_2, XCH_4, XCO, etc.
			EM27/SUN	5-6	CNESx1, GSMAx1, LERMAx1, FMIx1, KITx1, UoLx1	
	In-situ		Picarro	3	LMDx2, LSCEx1	In-situ concentration of CO_2, CH_4, CO
Aircrafts	SAFIRE ATR42	In-situ	Picarro	2	SAFIREx1, LSCEx1	In-situ concentration of CO_2, CH_4, CO
			SPIRIT	1	LPC2E	In-situ concentration of N_2O, CH_4, CO
		Lidars	CHARM-F	1	DLR	Weighted columns XCO_2, XCH_4
			LIVE	1	ONERA-DOTA	Wind profile
	DLR Cessna In-situ		Aerodyne Dual QCLS		DLR	In-situ concentration of CO_2, CH_4, CO
			MetPod		DLR	T, H_2O, 3D-wind
			Flask sampler		DLR	CH_4 isotopes
	Twin Otter		HyTES		NASA/JPL	CH_4, surface
			SPECIM		KCL	

MAGIC2021: Measurement scenarios



- **Natural emissions:**
  - Abisko lake.
  - Inari lake.
  - Region between Kiruna and Sodankylä *in coordination with CNES KLIMAT Stratospheric balloon flight from Kiruna*

- **Anthropogenic emissions:**
  - Oil and gas platforms in the Norwegian Sea.
  - Tornio LNG Terminal.
  - Meri Pori Power station.

- **Validation** of TROPOMI/Sentinel-5P, OCO-2, IASI/Metop-A/B/C

MAGIC: past, present and future

- **Conclusions on MAGIC 2018, 2019, 2020**
  - Evaluation of the merits of several instruments 'measuring' GHG.
  - Successful deployment of portable EM27/SUN and CHRIS to validate various missions on a day-to-day basis: OCO-2 (XCO2), TROPOMI (XCH4), GOSAT-1/2 (XCO2/XCH4) and IASI (MT-CH4).
  - Contribution to the validation of IASI during Metop-C commissioning: Temperature, humidity, trace gases.
  - Some comparisons with atmospheric transport models … to be continued (new partners welcome!).

- **MAGIC2021: Northern Scandinavia.**
  - 14-27 August 2021.
  - So far everything looks good!

- **MAGIC2022: Anthropogenic emissions around a mid-size city (Reims)**

- **Beyond:**
  - **2023: MicroCarb Cal/Val**
  - **2024: IASI-NG cal/val**
  - **>2023: Tropics**

Stay tune for more MAGIC news!
https://magic.aeris-data.fr